In the Lab: Diagnostics Innovation for Targeted and Effective Antibiotic Therapy

https://doi.org/10.1595/205651319X15502379725084 *Johnson Matthey Technol. Rev.*, 2019, **63**, (2), 100–102

JOHNSON MATTHEY
TECHNOLOGY REVIEW
www.technology.matthey.com

In the Lab

Diagnostics Innovation for Targeted and Effective Antibiotic Therapy

***Johnson Matthey Technology Review* features new laboratory research**

Dr Till Bachmann's laboratory is interested in diagnostics innovation in the context of targeted and effective antibiotic therapy. His research focuses on rapid point of care diagnostics to enable personalised approaches to medicine. This involves research on novel biosensors, molecular diagnostics, next generation sequencing and biomarkers as well as factors affecting the development and implementation of novel diagnostics. A major goal is to optimise antimicrobial therapy to reduce antimicrobial resistance and improve patient outcome in a wide range of diseases and healthcare settings.

Bachmann is currently Deputy Head of the Division of Infection and Pathway Medicine, Reader in Personalised Medicine in Infectious Diseases and Programme Director of the Clinical Microbiology & Infectious Diseases MSc at The University of Edinburgh, UK, as well as Programme Director of the Dual Award PhD in Integrated Biomedical Sciences at the Zhejiang University – University of Edinburgh Joint Institute in Haining, China. He has a PhD from biosensor research at the University of Stuttgart, Germany, and The University of Tokyo, Japan, as well as a German Habilitation in Analytical Biotechnology. In addition to his academic positions he has gained commercial experience as a founding CEO of Namaxx Genomic GmbH, Germany (2001–2006) and as Scientific Programme Director for MHC Scotland Ltd, UK (2013–2015). He also fulfils a variety of industrial and institutional advisory roles globally.

About the Researcher

- **Name:** Dr Till T. Bachmann
- **Position:** Deputy Head of Division of Infection and Pathway Medicine
- **Department:** Edinburgh Medical School
- **University:** The University of Edinburgh
- **Street:** The Chancellor's Building, 49 Little France Crescent
- **City:** Edinburgh
- **Post Code:** EH16 4SB
- **Country:** UK
- **Email:** till.bachmann@ed.ac.uk

About the Research

Research at the Bachmann group covers three major themes: diagnostics research, antimicrobial resistance and global health. The diagnostics research theme explores novel molecular detection modalities, biomarkers and assay integration strategies.

Rapid diagnostics is essential for the investigation, treatment and management of infectious diseases. Research in this discipline requires an understanding of disease pathologies and systems interaction as well as an interdisciplinary approach involving biomedical sciences, chemistry, physics, engineering, data science and social science. Diagnostics innovation has exciting potential as a

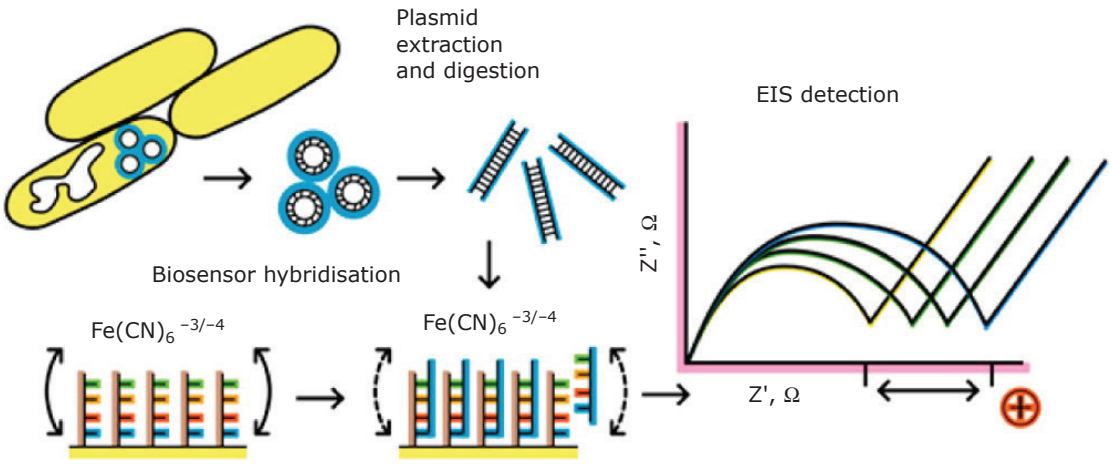

Fig. 1. The development of an electrochemical biosensor to detect *bla*$_{NDM}$, the gene encoding the emerging New Delhi metallo-beta-lactamase, using label-free electrochemical impedance spectroscopy (EIS). Reprinted with permission from (6). Copyright 2015 American Chemical Society

method to counter the global threat of antimicrobial resistance.

One approach is to use antimicrobial susceptibility testing (AST) to ensure that suitable antibiotics are prescribed. AST can also be used to monitor pathogens and identify the emergence of resistant organisms within an infected patient. However current AST methods typically take between 12 and 48 hours to produce results, too long for most clinical settings. Rapid testing, defined as results within an 8 h period, would allow results to be applied sooner and hence promote the optimised use of antimicrobials to prevent resistance developing. The development of rapid AST platforms is a complex process requiring intersectorial coordination between many stakeholders including industry, academia as well as the healthcare sector (1).

In the Bachmann Lab low-cost carbon screen-printed electrochemical sensors on ceramic substrates (2) as well as electrochemical methods to detect bacterial ribosomal RNA (3) and of genomic DNA extracted from methicillin-resistant *Staphylococcus aureus* (MRSA) (4) are being developed. Electrochemical impedance spectroscopy (EIS) can be used with chemically functionalised microelectrode arrays aiming towards designing new tests which will produce highly sensitive results and rapid diagnosis times with minimal training for operators (**Figure 1**) (5, 6).

In various collaborations, Bachmann looks at the development of novel microfluidic tools for biomedical applications. The growth of single-use components and disposable 'lab on a chip' technologies brings with it sustainability considerations. Recent work demonstrates laser worked poly(lactic acid) sheets as materials for such applications (7). Microfluidics have potential to improve detection of blood biomarkers at the point of care, where current techniques involve delays caused by the need for complex sample preparation (8).

Current projects include novel materials for the preparation of electrodes for label-free molecular detection of antibiotic resistance; an electrochemical biosensor for the detection of bacterial quorum sensing compounds in respiratory diseases; project DOSA - Diagnostics for One Health and User Driven Solutions for antimicrobial resistance; and early diagnosis of drug-induced liver injury using point of care detection of microRNA, with funding from industry, the Medical Research Council (MRC), UK, the Economic and Social Research Council (ESRC), UK, the Joint Programming Initiative on Antimicrobial Resistance (JPIAMR) and charities.

References

1. A. van Belkum, T. T. Bachmann, G. Lüdke, J. G. Lisby, G. Kahlmeter, A. Mohess, K. Becker, J. P. Hays, N. Woodford, K. Mitsakakis,

J. Moran-Gilad, J. Vila, H. Peter, J. H. Rex and W. M. Dunne, *Nat. Rev. Microbiol.*, 2019, **17**, (1), 51

2. E. A. Obaje, G. Cummins, H. Schulze, S. Mahmood, M. P. Y. Desmulliez and T. T. Bachmann, *J. Interdiscip. Nanomedicine*, 2016, **1**, (3), 93
3. G. Henihan, H. Schulze, D. K. Corrigan, G. Giraud, J. G. Terry, A. Hardie, C. J. Campbell, A. J. Walton, J. Crain, R. Pethig, K. E. Templeton, A. R. Mount and T. T. Bachmann, *Biosens. Bioelectron.*, 2016, **81**, 487
4. D. K. Corrigan, H. Schulze, I. Ciani, G. Henihan, A. R. Mount and T. T. Bachmann, *J. Electroanal. Chem.*, 2017, **786**, 58
5. D. K. Corrigan, V. Vezza, H. Schulze, T. T. Bachmann, A. R. Mount, A. J. Walton and J. G. Terry, *Sensors*, 2018, **18**, (6), 1891
6. J. M.-Y. Huang, G. Henihan, D. Macdonald, A. Michalowski, K. Templeton, A. P. Gibb, H. Schulze and T. T. Bachmann, *Anal. Chem*., 2015, **87**, (15), 7738
7. A. E. Ongaro, I. Keraite, A. Liga, G. Conoscenti, S. Coles, H. Schulze, T. T. Bachmann, K. Parvez, C. Casiraghi, N. Howarth, V. La Carubba and M. Kersaudy-Kerhoas, *ACS Sustainable Chem. Eng.*, 2018, **6**, (4), 4899
8. W. S. Mielczarek, E. A. Obaje, T. T. Bachmann and M. Kersaudy-Kerhoas, *Lab Chip*, 2016, **16**, (18), 3441

